COOLING TUBES FOR SHELVING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority of United States Provisional Patent Application Serial No. 60/506,532 filed September 26, 2003.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

REFERENCE TO A MICROFISHE APPENDIX

Not applicable.

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to shelving which may be adapted for use with refrigerators and other articles employing refrigeration, and, more particularly, shelving having means for facilitating spatial cooling.

Background Art

Previous types of shelving have been developed for use as shelves for refrigerators and other types of refrigeration apparatus. For example, refrigerator shelving is often designed with means for permitting selected movement of the shelf within the refrigerator, in addition to providing adequate support for the shelf. Design features of refrigerator shelving may also relate to spillage, prevention of bacteria buildup and the like.

Also, numerous developments have taken place over the past decades with respect to refrigerators themselves, along with refrigeration equipment. For example, substantial development has occurred in providing cooling apparatus for refrigerators. Past generations first

saw refrigerators adapted for use with conventional ice blocks. Since those early days, means for cooling (and maintaining cooling) in refrigeration space have developed into complex apparatus, with sophisticated electronics, motors, compressors and similar equipment.

Also, substantial research and development has occurred with respect to other aspects of refrigeration. For example, numerous developments have taken place with respect to insulative materials, and their properties for efficiently maintaining an interior cooled space. Another development has been undertaken with respect to efficiencies and continuities related to the refrigeration interior cooling at various locations within the interior. For example, one problem which occurs with respect to both residential and commercial refrigeration units relates to "hot spots." Hot spots are commonly known in the refrigeration industry, and may be characterized as areas within a cooled refrigeration interior that experience relatively warmer temperatures than desired. Such hot spots are typically measured by means of temperature gradients. These hot spots may occur, for example, in door bins of traditional side-by-side refrigeration units. In general, it is advantageous to provide cooling of a refrigerator interior in an efficient manner as is possible, with respect to issues such as cost, volume of refrigeration equipment and the like. Also, it is advantageous to attempt to minimize hot spots and their attendant temperature gradients as much as reasonably possible, again without substantially increasing cost, equipment volume or other undesirable properties.

Returning to the concept of refrigerator shelving, various types of shelving designs are known in the prior art. For example, Kane, *et al.*, U.S. Patent No. 5,564,809, issued October 14, 1996, discloses an encapsulated shelf assembly with a shelf support supporting a panel. The panel has an edge and a one-piece member encapsulating the panel edge and a substantial majority of the shelf support. The shelf assembly may be formed in a mold apparatus

which defines a mold cavity and uses a spacing plug to position the shelf support in a mold cavity of the apparatus in a location spaced from the sides of the mold cavity.

Herrmann, *et al.*, U.S. Patent no. 5,735,589, issued April 7, 1998, discloses a shelf assembly for a refrigerator compartment which includes a member slidably supported for extension and retraction on a support. The shelf member includes slide members which are preferably molded as a rim on an article support surface. A guide member extends from at least one, and preferably both, of the side members to guide the sliding movement. A stop on the guide member limits travel by engaging a limit surface on the shelf support.

Bird, *et al.*, U.S. Patent No. 5,454,638, issued October 3, 1995, discloses adjustable refrigerator shelving having a shelf rail for supporting a partial width shelf within a refrigerator compartment on first and second, spaced shelf racks vertically oriented in the compartment. The tracks releasably engage with a number of support brackets for cantilever support of one or more shelves at a plurality of vertically spaced locations. The shelf rail includes rearwardly projecting hooks at each of the two opposing ends for releasable engagement with the shelf tracks. Locking tabs are included on the hooks to retain the shelf rails on the track, while a rub strip is provided between the partial shelf and the shelf rail, along a top edge of the shelf rail.

Bird, *et al.*, U.S. Patent No. 5,429,433, issued July 4, 1995, describes a refrigerator shelf which is adapted for containment of spills on the shelf. The shelf includes a planer shelf member with a rim molded around the perimeter edge of the shelf member to form a liquid tight seal between the rim and the shelf member. The molded rim projects above the top surface of the shelf member to form a liquid dam for containing spills on the shelf member. In one embodiment, the shelf is slidably mounted to allow horizontal extension of the shelf, with

access to the rear portion of the shelf using slide guides molded into the rim along each side of the shelf. The shelf is cantilevered upon support brackets from the rear wall of a refrigerator to allow air flow around the shelf sides. The support brackets are adapted to support the shelf at a plurality of vertical positions.

Meier, *et al.*, U.S. Patent 6,120,720, issued September 19, 2000, discloses a method of manufacturing a glass shelf with a plastic edge. The glass panel is placed on a cavity of a mold with a peripheral edge of the cavity corresponding to the peripheral edge of the glass panel. The cavity has side cavity portions, each housing one of the shelf brackets. Plastic material is injected into the cavity adjacent corners, so that the forces of the injected material are essentially self balancing around the peripheral edge of the glass panel. In this manner, the glass panel is maintained in a substantially mating conformity with the cavity to produce a relatively consistently contoured frame.

The foregoing is merely a sample of the various types of prior art references which currently exist with respect to refrigerator shelving.

SUMMARY OF THE INVENTION

In accordance with the invention, a cooling tube system is provided which is adapted for use within an interior of a refrigeration apparatus. The cooling tube system facilitates distribution of cooling air within the interior of the refrigeration apparatus. The cooling tube system includes at least one cooling tube disposed within the refrigeration apparatus interior. Cooling air generation means are provided for generating a supply of cooling air. Air flow transmission means are provided, and are positioned so as to receive the supply of cooling air. The air flow transmission means also provides for transmitting the supply of cooling air to a

position adjacent a first end of at least one cooling tube. In this manner, at least a certain portion of the supply of cooling air is further transmitted into the first end of the cooling tube.

The one cooling tube also includes a second end opening to an interior of the refrigeration apparatus. A portion of the supply of cooling air flows through the second end of the one cooling tube. This air further flows into the interior of the refrigeration apparatus. The cooling air includes temperature and volume properties sufficient so as to provide an improvement of gradient temperature within the refrigeration apparatus. This improvement is relative to the state of the interior of the refrigeration apparatus in the absence of the cooling tube system.

The cooling tube system can comprise a plurality of cooling tubes, with the tubes disposed within an interior of the refrigeration apparatus. A first set of the plurality of cooling tubes can comprise a structural part of at least one refrigerator shelf. The shelf can be positioned within a freezer portion of the interior of the refrigeration apparatus, and the cooling air can comprise temperature and volume properties sufficient so as to provide for an improvement in freeze time for food items placed directly on the shelf, and for food items placed in direct contact with a stream of cooling air flowing into the refrigeration apparatus interior from a second end of at least one of the plurality of cooling tubes. This improvement occurs relative to freeze time which would exist for food items in the absence of the cooling tube system.

In accordance with these aspects of the invention, the improved freeze time can be at least 5%. Further, the improved freeze time can be in the range of 5% to 20%. Still further, the gradient temperature improvement can be at least 5%. Also, the gradient temperature improvement can be in the range of 5% to 25%.

In accordance with yet a further aspect of the invention, a first set of the plurality of cooling tubes can be formed with a straight configuration. Alternatively, a first set of the plurality of cooling tubes can be formed with angle-cut configurations. Still further, the first set of cooling tubes can also comprise formed cooling tubes. The first set of cooling tubes can further be formed with air dam configurations.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The invention will now be described with reference to the drawings, in which:

FIG. 1 is a perspective view of a refrigerator shelf employing a cooling tube system in accordance with the invention;

FIG. 2 is a generalized block diagram of a refrigerator interior, illustrating example positioning of refrigerator shelving employing the cooling tube system in accordance with the invention, and further showing an example of how airflow can be directed into the cooling tubes;

FIG. 3 is a side elevation view of a refrigerator shelf utilizing cooling tubes in accordance with the invention, and having straight configurations;

FIG. 4 is a front elevation view of the refrigerator shelf of FIG. 3;

FIG. 5 is a side elevation view of a refrigerator shelf in accordance with the invention, utilizing cooling tubes having an angle-cut configuration;

FIG. 6 is a side elevation view of a refrigerator shelf in accordance with the invention, utilizing formed cooling tubes;

FIG. 7 is a side elevation view of a refrigerator shelf in accordance with the invention, utilizing formed cooling tubes with an air dam configuration; and

FIG. 8 is a front elevation view of the refrigerator shelf utilizing formed cooling tubes with an air dam configuration as illustrated in FIG. 7.

DETAILED DESCRIPTION OF THE INVENTION

The principles of the invention are disclosed, by way of example, in certain embodiments of cooling tube systems in accordance with the invention, as illustrated in FIGS. 1 – 8. As described in subsequent paragraphs herein, cooling tube systems in accordance with the invention are adapted for use within an interior of a refrigeration apparatus described subsequently herein. The cooling tube system facilitates distribution of cooling air within the interior of the refrigeration apparatus. As also described in subsequent paragraphs herein, the cooling tube systems in accordance with the invention may employ a number of cooling tubes disposed within the refrigeration apparatus interior. Further, cooling tubes in accordance with the invention can be utilized so as comprise a structural part of refrigerator shelving, including at least one refrigerator shelf. Various embodiments of cooling tube systems in accordance with the invention can be used to direct cooling air in various directions, and assist in reducing undesirable temperature gradients and hot spots throughout the interior of the refrigeration unit. While providing the foregoing air distribution features, the cooling tubes and the cooling tube systems in accordance with the invention may also provide shelf support for refrigerated items.

Turning to the drawings, a cooling tube system 100 is illustrated in the perspective view of FIG. 1. Therein, the cooling tube system 100 is illustrated as comprising a structural part of a refrigerator shelf 102. The refrigerator shelf 102 may have a substantially planar and rectangular configuration. The refrigerator shelf 102 can include a frame 104. The frame 104 comprises, in the particular embodiment illustrated in FIG. 1, a series of three frame wires 106. The frame wires 106 are each substantially equal in length and are spaced in a

parallel relationship. The frame wires 106 comprise a front wire 108, intermediate wire 110 and rear wire 112. The front wire 108 and rear wire 112 may be positioned equidistant from the intermediate frame wire 110. The frame wires 106 may be constructed of wire or similar materials, and do not form any of the particular novel concepts of the invention.

Secured above and supported on the frame wires 106 are a set of cooling tubes 114. In the particular embodiment illustrated in FIG. 1, the cooling tubes 114 each comprise an elongated configuration with a substantially hollow interior 116. The hollow interior 116 may be formed and shaped in various configurations. For example, the cooling tubes 114 illustrated in FIG. 4 each have a hollow interior 116 formed by a tube enclosure 118 with a substantially circular configuration. With the particular refrigerator shelf 102, the cooling tubes are each spaced in a parallel relationship, with each tube being substantially equidistant from each of its adjacent tubes. The cooling tubes 114 may be constructed of various types of materials, including metal and plastic. Also, various types of connection means may be utilized for securing the cooling tubes 114 to the frame wires 106. For example, the frame wires 106 may be welded to the cooling tubes 114. Also, cooling tubes of various lengths and diameters may be utilized. For example, it has been found that for the use of cooling tubes in accordance with the invention within refrigerator apparatus or refrigerator units of conventional size, a diameter in the range of 0.1875 to 0.5 inches for the cooling tubes may be utilized.

To illustrate the spatial relationship and the use of the cooling tube system 100 in a refrigeration apparatus, attention is directed to FIG. 2. Therein, a refrigeration apparatus 120 is illustrated in partial sectional view as a side, elevation section. For purposes of simplicity, the refrigeration apparatus 120 may be referred to herein as a "refrigeration unit" 120 or, alternatively, a "refrigerator" 120. The refrigerator 120 illustrated in FIG. 2 can be a relatively

conventional refrigerator, commercially available from a number of manufacturers. However, FIG. 2 also illustrates the refrigerator 120 as incorporating a cooling tube system 100 in accordance with the invention. The refrigerator 120 includes a top portion 122, front portion 124, rear portion 126 and bottom portion 128. The refrigerator also consists of side portions 131, only one of which is illustrated in FIG. 2. These portions of the refrigerator 120 form a refrigerator interior 129. Although a particular refrigerator is illustrated in FIG. 2, the cooling tube systems 100 in accordance with the invention may be utilized in various types of refrigerators and other refrigeration apparatus. Further, cooling tube systems in accordance with the invention may be utilized in the conventional refrigeration portion of a refrigerator and/or within freezer portions of refrigerators.

In the particular refrigerator 120 illustrated in FIG. 2, cooling air equipment 130 is located near a bottom section of the refrigerator 120, separate and apart from the interior 129. Such cooling air equipment typically consists of various electronics, along with motor and compressor equipment. Such equipment is well known in the refrigeration arts. As part of the cooling air equipment 130, a fan 132 is typically associated therewith. The fan 132 may be utilized to direct cool or cooling air (illustrated by the arrows 138) upwardly through a cooling air corridor 134. The cooling air corridor 134 is also conventional in refrigerator design, and may be adjacent the rear 126 of the refrigerator 120, or, in other refrigerator designs, may be located elsewhere. In the particular refrigerator 120, although the air corridor 134 is separate and apart from the refrigerated interior 129, the forward wall 137 of the air corridor 134 (which also may be a rear wall of the refrigerator interior 129) includes a series of spaced apart vents 136. The vents 136 may be conventional in design and provide a means for the cooling air 138 to be

directed into the interior 129 of the refrigerator 120. The vents 136 may be any of a number of conventional designs.

As the cooling air 138 flows upwardly through the air corridor 134, it passes through the vents 136. As further illustrated in FIG. 2, the refrigerator shelves 102, with the cooling tubes 114, are positioned so that each of the shelves 102 illustrated in FIG. 2 is adjacent a separate one of the vents 136. In this manner, as the cooling air 138 flows through the vents 136 into the refrigerator interior 129, it flows through rear hollow ends 140 of the cooling tubes 114. With the elongated configuration of the cooling tubes 114, and with their configuration in the refrigerator interior 129 directed from the rear 126 to the front 124 of the refrigerator, the cooling air 138 flowing through the tubes 114 is directed toward the front 124 of the refrigerator 120. It is near the front of refrigerators (including, for example, within door bins and the like) where hot spots and temperature gradients are most likely to occur. With the use of the cooling tubes 114 as illustrated in FIG. 2, the cooling air 138 is "forced" to be dispersed not only adjacent the vents 136, but also through the hollow interiors 116 of the cooling tubes 114 and through the front hollow ends 142 of the cooling tubes 114. In this manner, more efficient cooling air distribution is provided. Further, and in accordance with the invention, the cooling tubes 114 not only act to more efficiently disperse the cooling air 138, but also act as supporting elements of the refrigerator shelf 102 for supporting various types of refrigerated items (not shown).

The cooling tube systems 100 in accordance with the invention may utilize various configurations of cooling tubes 114. These configurations are primarily illustrated in FIGS. 3 – 8. Turning specifically to FIG. 3, a side elevation view of the refrigerator shelf 102 is illustrated. In this particular embodiment of the cooling tube system 100, the cooling tubes 114

comprise straight tubes 144, one of which is shown in the side elevation view of FIG. 3. The straight tube 144 is of an elongated and straight configuration. The cooling tube 144 is characterized as a "straight" tube, in that the rear end cut 145 of the tube enclosure 118 is straight and perpendicular to the longitudinal orientation of the tube 144. It is the use of straight tubes 144 which is illustrated in the refrigerator shelf 102 of FIG. 1. FIG. 4 illustrates the front elevation view of the refrigerator shelf 102 illustrated in FIG. 3. Again, as earlier mentioned, the hollow interior 116 may be of any configuration, including the oval or elliptical configuration illustrated in FIG. 4.

FIG. 5 illustrates another embodiment of a cooling tube system 100 in accordance with the invention. Therein, the cooling tubes 114 are illustrated as comprising angled tubes 146. Only one of the angled tubes 146 is illustrated in the side elevation view of FIG. 5. With the particular angled tube 146, the front end cut 147 has a straight configuration, similar to the front end cut 147 of straight tube 144 illustrated in FIG. 3. However, the rear portion of the angled tube 146 includes a rear angled end cut 148. This end cut 148 comprises a cutting of the end of the tube enclosure 118 at an acute angle relative to the longitudinal orientation of the tube enclosure 118. In the particular embodiment illustrated in FIG. 5, the end cut 148 may be of a 45° angle. Such an angled end cut may be utilized to distribute the cooling air 138 in a direction different from that which would be distributed by the straight tube 144.

A further embodiment of a cooling tube system 100 in accordance with the invention is illustrated in FIG. 6. Therein, a side elevation view is shown of the refrigerator shelf 102, but with the cooling tubes 114 comprising formed tubes 150. As illustrated in FIG. 6, only one of the formed tubes 150 is visible. The visible formed tube 150 includes a angled rear section 152 which may be upwardly angled as illustrated in FIG. 6. In addition to the angled rear

section 152, the rear end cut 158 of the angled section 152 may also be angled. At the forward portion of the formed tube 150, an angled front section 154 is utilized, which is angled downwardly relative to the horizontal plane on which the elongated section of the formed tube would lie. The angled front section 154 may also include an end cut 156 which is correspondingly angled. This type of formed tube configuration may be utilized to again provide a differing redistribution of cooling air 138 throughout the refrigerator interior 129. In addition to the angled configuration illustrated in FIG. 6, a somewhat different formed tube configuration could be utilized, where the angled rear section 152 was angled downwardly relative to the horizontal plane of the longitudinal orientation of the formed tube 150. Correspondingly, the angled front section 154 could be angled upwardly relative to the horizontal. Such a configuration is illustrated with respect to the cooling tubes 114 shown in FIG. 2.

A still further embodiment of a cooling tube system 100 in accordance with the invention is illustrated in FIG. 7. FIG. 7 illustrates, as does FIGS. 4 and 6, a side elevation view of the refrigerator shelf 102. However, rather than use of the straight tubes 144, the configuration illustrated in FIG. 7 employs air dam tubes 160, only one of which is illustrated in the side elevation view of FIG. 7. The visible air dam tube 160 includes, at its forward portion, a front angled section 162, similar to the angled section 154 of the formed tube 150 illustrated in FIG. 6. The front angled section 162 also includes an end cut 164 which may be angled. Still further, the air dam tube 160 may include a rear angled section 166, which is angled upwardly relative to the horizontal plane of the longitudinal orientation of the air dam tube 160. Attached to the end of the rear angled section 166 is a conventional air dam 168 having the configuration illustrated in FIGS. 7 and 8. The air dam 168 may be interconnected or otherwise coupled to the rear angled section 166 by any suitable and conventional means. The air dam 168 essentially

"ties together" the air dam tubes 160. The air dam 168 may be constructed of metal, plastic or other similar materials. The air dam 168 may be utilized to improve and increase flow of the cooling air 138 into the tubes 160.

Various types of cooling tube systems 100 in accordance with the invention have been illustrated and disclosed herein. As described, the cooling tube systems 100 utilize cooling tubes for directing air flow to various sections of compartments of a refrigerator. These compartments may consist of fresh food or freezer compartments of a conventional refrigerator or other type of refrigeration equipment. As further described and illustrated, the cooling tubes of the cooling tube systems 100 act not only to facilitate air flow direction, but also to support, on refrigerator shelving, stored foodstuffs and the like.

As further described herein, the cooling tube systems 100 act in part to redistribute or direct cooling air to "hot spots" within refrigeration units, such as door bins or the like of traditional side-by-side refrigerators. Also, cooling tube systems 100 in accordance with the invention can be designed to redistribute air in various directions. This can be achieved by placing the cooling tubes at various angles, and could include forming the tubes at each end. In this regard, although not particularly shown in FIG. 1, the cooling tubes 114 illustrated with the refrigerator shelf 102 could be angled along a horizontal plane, rather than being directed in a straight line from the rear to the forward portion of a refrigerator.

With the forgoing, cooling tube systems 100 in accordance with the invention assist in maintaining more predictable temperature gradients within a refrigerator, as a result of directed air flow. Still further, the refrigerator shelves 102 utilizing the cooling tube systems 100 can create air curtains which lead to more efficient use of refrigerator units, and potential energy usage reduction. Still further, with the cooling tube systems 100 in accordance with the

invention, more rapid cooling of food items placed directly on the cooling tubes themselves will occur, as oppose to traditional shelving methods.

In accordance with the foregoing description, the components of the refrigerator 120 which are utilized to generate the cooling air can be characterized as cooling air generation means. Also, components of the refrigerator 120 which facilitate air flow to the cooling tubes 114 can be characterized as air flow transmission means. This air flow transmission means can further be characterized as receiving the cooling air 138 and transmitting the same to positions adjacent ends of the cooling tubes 114. As also described herein, the cooling air can have temperature and volume properties sufficient so as to provide an improvement of gradient temperature within the refrigerator 120. This is an improvement relative to the state of the interior of the refrigerator 120 which would exist in the absence of the cooling tube system 100. In this regard, it is believed that cooling tube systems in accordance with the invention can achieve gradient temperature improvements in a range of at least 5% to 25%.

Still further, and as earlier stated herein, the cooling tubes 114 can be utilized within freezer portions of the refrigerator 120. In this regard, the cooling air can comprise temperature and volume properties which are sufficient so as to achieve an improved freeze time, particularly for food items which are placed directly on a refrigerator shelf having a structural part formed by the cooling tubes 114. Also, this freeze time improvement would occur for food items which were placed in direct contact with the stream of cooling air flowing into the freezer portion from the cooling tubes 114. In this regard, it is believed that with appropriate temperature and volume properties, cooling tube systems in accordance with the invention can provide for an improved freeze time in the range of at least 5% to 20%. This is an improvement

relative to freeze time which would exist for the frozen food items in the absence of the use of a cooling tube system 100 in accordance with the invention.

In this regard, it should be noted that cooling tube systems in accordance with the invention do not require any "special" or "oversized" fans or specially designed cooling air corridors 134 to properly function. Conventional apparatus within conventional refrigerators can be used to generate the cooling air. No "special" air flow volume or air speed is required. Further, the cooling air temperature can be conventional. For example, the temperature of the cooling air may be in the range of -15° F to 5° F when first applied to the cooling tubes. However, the invention is not limited to specific air flow volumes or temperatures.

It will be apparent to those skilled in the pertinent arts that other embodiments of cooling tube systems in accordance with the invention can be designed. That is, the principles of cooling tube systems in accordance with the invention are not limited to the specific embodiments described herein. Accordingly, it will be apparent to those skilled in the art that modifications and other variations of the above-described illustrative embodiments of the invention may be effected without departing from the spirit and scope of the novel concept of the invention.